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(54) INDUCTION FURNACE

(71) We, COMPAGNIE GENERALE D'ELECTRICITE S.A., a French Body Corporate of 54 rue La Boétie, 75382 Paris Cedex 08, France, do hereby declare the invention for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to an induction furnace using a tubular induction heater made of a material which is oxidisable at high temperature.

Preferred embodiments of the invention provide a heater jacket through which an elongate glass rod or tube can be passed for vapour phase deposition at about 2000°C. Such techniques are needed for the manufacture of glass fibres for telecommunications. Naturally the furnace of the invention also has other applications.

The present invention provides an induction furnace comprising:

a tubular induction heater disposed vertically and made of a material which is oxidisable at high temperature;

a toroidal chamber enclosing said heater, the chamber being constituted by an assembly of superposed wall-forming members including: a horizontal lower plate; an outer tube and an inner tube which are substantially co-axial and rest vertically on said lower plate with the heater disposed co-axially between the tubes; and an upper plate resting horizontally on the tubes; the upper and the lower plates each being provided with an opening to the bore of the inner tube to enable objects to be passed through the heater for heating;

an induction coil disposed around the outer tube for receiving high-frequency electric current to induce heating eddy currents in the heater; and

means for introducing an inert gas into said chamber at sufficient pressure for the gas contained in the chamber to escape through gaps between the contact surfaces of the said superposed wall-forming members.

Preferably the inner tube is made of zirconia in order to withstand a temperature of about 2000°C.

An embodiment of the invention is described by way of example with reference to the sole figure of the accompanying drawing which is an axial cross-section of an electric furnace.

The furnace comprises a tubular graphite induction heater 1 housed in a generally toroidal chamber 22 and heated by means of eddy current induced by a coil 2. The heater 1, the coil 2 and the toroidal chamber 22 share a common vertical axis 20. The chamber 22 is supplied with an inert gas via a gas supply pipe 10, this gas fills the chamber 22 and protects the heater 1 from oxidizing. The bore of the toroidal chamber 22 is open at both ends to allow an elongate member, such as a glass rod (not shown), to pass along the vertical axis 20 of the furnace for heat treatment as it passes through the tubular heater.

The coil 2 is made of copper tubing whose ends 3 and 4 are connected, in operation, to a source of high-frequency electric current, not shown. A cooling fluid, such as water, can be circulated inside the tube 2 during heating.

The heater 1 is immersed in an atmosphere of argon (or any other gas that does not react with graphite at high temperature) which is enclosed in the chamber 22. This chamber is constituted by an assembly of superposed wall-forming members, leaving sufficient gaps between touching members for the inert gas to leak out of the chamber 22. The inert gas is continuously replenished via the pipe 10.

The wall-forming members of the cham-

ber 22 comprise: a horizontal lower plate 18 having a central opening 19 and four concentric grooves in its upper surface; an outer tube 6 received in the outermost concentric groove; an inner tube 21 received in the innermost concentric groove; and an upper plate 8 resting on the tubes 6 and 21. The tops of the tubes 6 and 21 are received in corresponding concentric grooves in the lower surface of the upper plate 8 which also includes a central opening 14 and a hole 9 which communicates with the toroidal chamber 22 defined by the wall-forming members and which receives the gas supply pipe 10.

The wall-forming members are all made of silica glass except for the inner tube 21 which may be made of zirconia for operation at higher temperatures than can be supported by silica, e.g. for operation at about 2000°C.

The heater 1 is supported in the toroidal chamber 22 by a silica stand 11 which is received in the second concentric groove from the centre of the lower plate 18. The upper end of the stand 11 has a silica guide collar 12 projecting upwardly therefrom to receive the lower end of the heater 1. A thermally insulative tube 16 made of porous alumina is received in the third concentric groove from the centre of the lower plate 18 and surrounds the heater 1.

The furnace operates as follows:

An inert atmosphere is established inside the chamber 22 by admitting the inert gas via the supply pipe 10 at a slightly higher pressure than the surrounding air. The air escapes from the chamber 22 through the gaps between its wall-forming members, and after an initial period the atmosphere inside the chamber 22 is substantially free of air. The inert gas continues thereafter to leak out slowly throuhg the same gaps.

The ends 3 and 4 of the coil 2 are then connected to the source of high-frequency current and a flow of cooling water is started through the coil 2. Eddy currents are induced in the heater 1 by the electric current flowing in the coil 2 and the temperature of the heater 1 rises rapidly and it may be raised to about 2000°C without danger of the graphite of the heater 1 oxidising.

An elongate glass rod or pipe for use in the manufacture of optical fibres can be passed along bore of the furnace via the central openings 14 and 19 to receive heat treatment such as vapour phase deposition. The elongate rod or pipe can be of greater length than the bore of the furnace and can receive heat treatment over substantially the whole of this greater length by virtue of relative movement between the glass and the furnace. In effect the furnace forms a heating jacket suitable for use with elongate objects, whether particularly adapted to the glass fibre industry or to some other application.

To give an idea of dimensions, the furnace shown may have an outer diameter of 60 mm, a height of 56 mm and may obtain a temperature of about 2000°C for an electric power consumption of about 4 kW. The frequency of the inducing current may lie between 600 kHz and 20 kHz and the inert gas may be argon supplied at a flow rate of about 1 litre per minute.

With such a furnace, it is possible to reuse the graphite heater 1 for several heating operations since its loss of weight between two successive operations is negligible. Further the furnace is easy to dismantle and re-assemble when there is a need to replace the graphite heater 1. Also due to the simplicity of its structure it is easy to produce rapidly and cheaply such a furnace which is adapted to any particular heating problem that may arise in practice.

WHAT WE CLAIM IS:—

1. An induction furnace comprising:

—a tubular induction heater disposed vertically and made of a material which is oxidisable at high temperature;

—a toroidal chamber enclosing said heater, the chamber being constituted by an assembly of superposed wall-forming members including: a horizontal lower plate; an outer tube and an inner tube which are substantially co-axial and rest vertically on said lower plate with the heater disposed co-axially between the tubes; and an upper plate resting horizontally on the tubes; the upper and the lower plates each being provided with an opening to the bore of the inner tube to enable objects to be passed through the heater for heating;

—an induction coil disposed around the outer tube for receiving high-frequency electric current to induce heating eddy currents in the heater;

and means for introducing an inert gas into said chamber at sufficient pressure for the gas contained in the chamber to escape through gaps between the contact surfaces of the said superposed wall-forming members.

2. A furnace according to claim 1 wherein the inner tube is made of zirconia in order to withstand a temperature of about 2000°C.

3. A furnace according to claim 1 or 2, further including a thermally insulative tube co-axially disposed between the heater and the outer tube.

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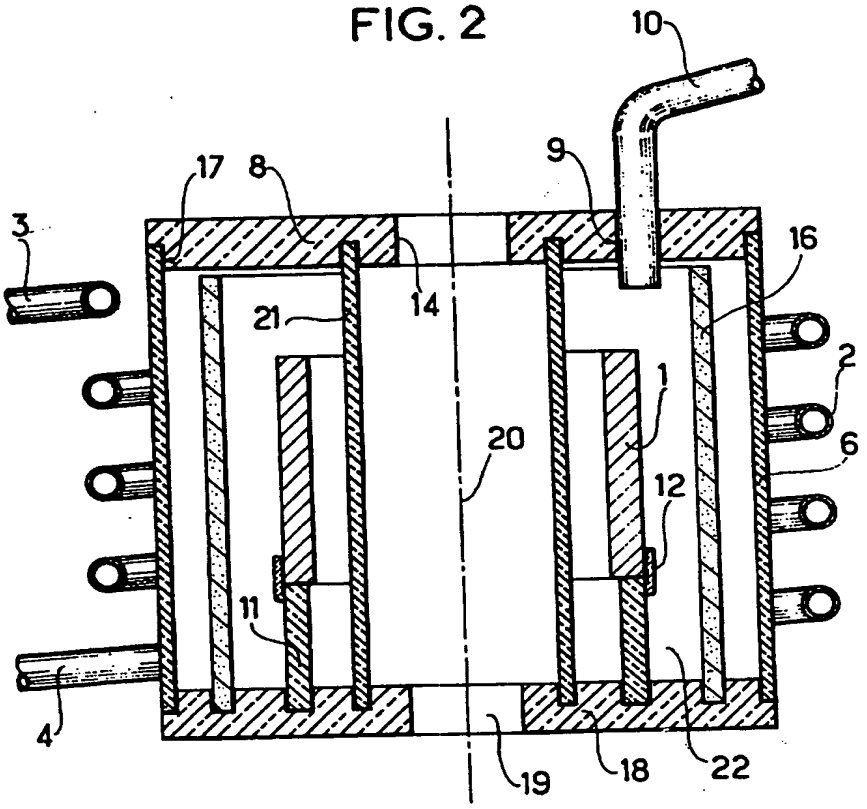
COMPLETE SPECIFICATION

FIG. 2



4. A furnace according to claim 1, 2 or 3, wherein the heater is held above the lower plate by a cylindrical stand supported by the lower plate.

5. An induction furnace substantially as herein described with reference to and as illustrated in the accompanying drawing.

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